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Updated list of Collembola species currently recorded from South Africa

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Abstract

Understanding the abundance and richness of species is one of the most fundamental steps in effecting their conservation. Despite global recognition of the significance of the below-ground component of diversity for ecosystem functioning, the soil remains a poorly studied terrestrial ecosystem. In South Africa, knowledge is increasing for a variety of soil faunal groups, but many still remain poorly understood. We have started to address this gap in the knowledge of South African soil biodiversity by focusing on the Collembola in an integrated project that encompasses systematics, barcoding and ecological assessments. Here we provide an updated list of the Collembola species from South Africa. A total of 124 species from 61 genera and 17 families has been recorded, of which 75 are considered endemic, 24 widespread, and 25 introduced. This total number of species excludes the 36 species we consider to be dubious. From the published data, Collembola species richness is high compared to other African countries, but low compared to European countries. This is largely a consequence of poor sampling in the African region, as our discovery of many new species in South Africa demonstrates. Our analyses also show that much ongoing work will be required before a reasonably comprehensive and spatially explicit picture of South Africa's springtail fauna can be provided, which may well exceed 1000 species. Such work will be necessary to help South Africa meet its commitments to biodiversity conservation, especially in the context of the 2020 Aichi targets of the Convention on Biological Diversity.

Keywords

Biodiversity, endemicity, soil fauna, introduced species, taxonomy

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Introduction

The documentation of biodiversity is an essential first step for its conservation. A major barrier to so doing for invertebrates is a lack of taxonomic information on various groups. This taxonomic impediment and its implications for biodiversity studies have been widely discussed (Godfray 2002, Samper 2004). Despite these challenges, taxonomic knowledge continues to increase globally (Nilsson-Örtman and Nilsson 2010, Joppa et al. 2011, Platnick 2014, van Noort 2014). Nonetheless, given rapid environmental change and its effects on biodiversity (Butchart et al. 2010), it is unclear what the rate of extinction is for many groups (Pimm et al. 2010, Costello et al. 2013), complicating conservation efforts and assessments of their efficacy, thus underscoring the urgency to further document global biodiversity (Dirzo and Raven 2003, Bacher 2012).

This situation is as true for southern Africa as it is elsewhere. Knowledge of the South African fauna is increasing rapidly, especially in the case of a wide range of invertebrate groups (Foord et al. 2002, Robertson 2000, 2002, Parr et al. 2003, Dippenaar-Schoeman et al. 2006, Dippenaar-Schoeman and González Reyes 2006, Haddad and Dippenaar-Schoeman 2006, Hlavac 2007, Rousse and van Noort 2013). Nonetheless, many groups still remain relatively poorly studied, especially soil-dwelling taxa, which are essential for both above- and below-ground ecosystem functioning (Wardle et al. 2004, Hugo-Coetzee and Avenant 2011, Janion et al. 2011a). At the same time, considerable impacts on biodiversity continue to be documented as a consequence of habitat modification for agriculture and urban development, biological invasions, pollution, and climate change (Erasmus et al. 2002, Rouget et al. 2003, Biggs et al. 2008, Chown 2010, Pryke and Samways 2010, Huntley and Barnard 2012, Liu et al. 2012). In consequence, much need exists for documenting and understanding biodiversity and the processes underlying its variation across a wide range of groups, and especially the soil fauna.

Collembola are amongst the most widespread and abundant soil arthropods (Petersen and Luxton 1982, Hopkin 1997). Despite their obvious significance in soil systems, their utility as bioindicators (Lawrence 1953, Hopkin 1997, van Straalen 1998), their significance in the alien species faunas of many areas (Roques et al. 2009, Terauds et al. 2011), and the current growth in both morphological (Deharveng 2004) and molecular (Hogg and Hebert 2004, Rougerie et al. 2009) means to assess their diversity, they remain poorly known in South Africa. Indeed, by comparison with other regions of the world (Deharveng 2004), and other invertebrate taxa in the country (Scholtz and Chown 1995, Robertson 2000, Foord et al. 2011, Dippenaar-Schoeman 2014), knowledge of the group can be considered scanty.

The first attempt to collate all taxonomic information on the Collembola of South Africa was undertaken by Paclt (1959), listing *ca.* 65 species. Subsequently, an unpublished list entitled "Aquatic Collembola of South Africa" was made available online (P. Greenslade, no date), while Thibaud (2013) listed most publications until 2013. To date there are 38 publications on Collembola recorded or described from South Africa, the earliest by Börner (1908). Most notably, comprehensive descriptions were made by

Yosii (1959), Paclt (1959, 1964, 1965, 1967), Coates (1968a, 1968b, 1969), Weiner and Najt (1991, 1998, 1999), and later Barra (1994, 1995, 1997, 1999, 2001, 2002, Barra and Weiner 2009). However, little other work has been done and the current list of species for the country is clearly an underestimate, with an incomplete understanding of which species might be introduced and thus might have substantial impacts, despite the fact that such impacts have been suggested for the country (Annecke and Moran 1982, Liu et al. 2012).

To address this substantial gap in the knowledge of soil biodiversity, a collaborative project was established in 2008 (Janion et al. 2011a, Bengtsson et al. 2011, 2012). Besides large-scale sampling and systematic assessments, which have resulted in new discoveries and species descriptions (Janion et al. 2011b, Potapov et al. 2011, Janion et al. 2012, 2013), a major component of the project has comprised the compilation of all currently available information on Collembola recorded from South Africa. Here we present this compilation as an updated checklist. It will provide a starting point for understanding the diversity of this group, as has been done for other geopolitical regions (e.g. Culik and Zeppelini 2003, Abrantes et al. 2010, 2012), and will assist South Africa to meet its obligations under the Convention on Biological Diversity (see for example Aichi Target 9 on identifying invasive alien species, and Aichi Target 17 on a national biodiversity strategy, http://www.cbd.int/sp/targets).

Methods

All publications on Collembola species described or recorded from South Africa were collated from Salmon (1964) and Thibaud (2013). The list was checked and completed using the website "Checklist of the Collembola of the World" (Bellinger et al. 2014), the bi-annual bibliographical lists issued by the Museum National d'Histoire Naturelle (Paris, France), Zoological Record, Web of Science™ (full date range of 1900 to 2014), and genus or species revisions from taxonomic journals sourced from the references identified using the original search methods. Nomenclature follows Bellinger et al. (2014), as it may have changed for certain taxonomic groups since the original description of the species. All published papers and webpages were examined and the following information was recorded when available: collection details including date, collector, province, place, nearest town, habitat type, and collection method, type locality and accession number if given. Only species with full species names were included in the species list of Table 2, thus excluding morphospecies identified to genus or to suspected species (e.g. *Seira* sp. or *Isotomurus* cf. *maculatus*). However, every record from the literature is listed in the Supplementary material (Suppl. material 1). The species were assigned a South African province from the locality recorded. From these points a species richness map was produced in ArcMap V10.2 (ESRI 2014).

The species were also divided into the following categories based on their distribution: 1) endemic if they were described from South Africa and have not been recorded elsewhere, 2) introduced if there is evidence from the literature that the species was

introduced from another place, 3) widespread if the species is also present outside of South Africa but its origin is unknown, thus not considered introduced, or 4) dubious, when the species name given in the literature is considered a misidentification based on current taxonomic knowledge or if subsequent taxonomic work suggested this is the case (see Suppl. material 1).

To make an estimate of expected species richness, we used data collected from extensive sampling in the Western Cape Province of South Africa, which has been the main focus of much work on the group. The dataset comprises a total of 217 samples we obtained using several sampling techniques (see below) in as many localities and different microhabitats as possible throughout the Western Cape, including Afromontane forest, different fynbos vegetation types (see Mucina and Rutherford 2006), intertidal habitats, caves, and disturbed areas such as gardens and agricultural areas. Leaf litter, moss, rotten wood and soil samples were taken at different sampling sites over the duration of the project (2008–2012), and occasionally sieving and pitfall traps were also used. Typically, samples were extracted using a Berlese-Tullgren approach for five to seven days, or until dry (Berlese 1905, Tullgren 1918, Hopkin 1997). In addition, active searching was done in the field. Riparian soil was washed for water-dependent species, which were collected with a fine brush on the surface of water. Fine sand such as sea sand was washed in the laboratory and animals were also collected with a brush. Vegetation such as branches from bushes, fynbos shrubs, and grasses was beaten over a tray and animals were collected by means of an aspirator. All samples are stored in 96–99% ethanol at the Centre for Invasion Biology (C·I·B) Stellenbosch, or the Museum National d'Histoire Naturelle (MNHN) Paris. As identifications and species descriptions are still ongoing, we only used confirmed morphospecies for the purpose of calculating the number of species expected for the Western Cape.

Sampled-based rarefaction curves were plotted to estimate the number of species for the Western Cape, using Chao1 and Jacknife 2 in EstimateS V8.2.0 (Colwell 2009). Jacknife 2 does not require data to be normally distributed and provides conservative, but accurate estimates (Magurran 2004). Sampling is considered adequate when the rarefaction curves and the estimators converge at the highest observed values (Longino et al. 2002).

Results

According to the literature, a total of 160 species from 61 genera and 17 families have been recorded from South Africa (Table 1), with a relatively steady increase in descriptions since the first records in the early 1900s (Fig. 1). Of the recorded species, 36 are considered dubious, most of them misidentified records from Paclt (1959, 1967). Of the other species, 75 are endemic, 25 are thought to be alien species introduced to the country by human activity, and 24 have a widespread distribution, at least so far as current sampling indicates (Table 2). The majority of species have been recorded from

Table 1. A summary of the Collembola species recorded from South Africa based on the literature.

	Number of species recorded from literature	Number of species accepted from literature	Introduced	Endemic	Widespread
PODUROMORPHA					
Hypogastruridae	19	11	4	5	2
Brachystomellidae	6	6	1	5	0
Neanuridae	16	15	2	10	3
Odontellidae	3	2	0	1	1
Onychiuridae	5	1	0	1	0
Tullbergiidae	8	7	1	3	3
TOTAL	**57**	**42**	**8**	**25**	**9**
ENTOMOBRYOMORPHA					
Isotomidae	23	19	5	8	6
Entomobryidae	49	36	8	25	3
Cyphoderidae	10	9	0	8	1
Paronellidae	1	1	0	0	1
Tomoceridae	1	1	0	1	0
TOTAL	**84**	**66**	**13**	**42**	**11**
NEELIPLEONA					
Neelidae	1	1	0	0	1
TOTAL	**1**	**1**	**0**	**0**	**1**
SYMPHYPLEONA					
Sminthurididae	2	1	0	0	1
Katiannidae	5	4	1	1	2
Dicyrtomidae	2	2	1	1	0
Bourletiellidae	7	7	1	6	0
Sminthuridae	2	1	1	0	0
TOTAL	**18**	**15**	**4**	**8**	**3**
TOTAL	**160**	**124**	**25**	**75**	**24**

the Western Cape (67 species), Kwazulu-Natal (46 species) and the Eastern Cape (20 species) (Fig. 2). Records from the other provinces are sparse (1–10 species), with the North West Province and Limpopo having the lowest recorded richness (three and one species, respectively). Although many authors did not indicate the habitat type where collections took place (Supplementary Material Suppl. material 1), the majority mentioned were from sites that are within the forest biome (see Mucina and Rutherford 2006 for full details of South Africa's biomes and vegetation types). However, other vegetation types mentioned include those of the grassland biome and disturbed areas such as gardens, orchards and plantations.

The sample-based species rarefaction curve for the Western Cape did not reach an asymptote (Fig. 3). The two richness estimators (Jacknife2: 348 species, Chao1 with 95% Confidence Intervals: 323, lower CI: 270, upper CI: 416) suggest that at least 6–7 times more than the number of species currently recorded from the literature will be found in the province, given the steep slope of the non-asymptotic curve.

Table 2. Collembola species recorded from South Africa, with "Current species name" as confirmed name (Bellinger et al. 2014), and "Name published in source" as name used in the original source when different from current species name. Abbreviations used: South Africa (SA), Western Cape (WC), Eastern Cape (EC), Kwazulu-Natal (KZN), Gauteng (G), Limpopo (L), Free State (FS), Northern Cape (NC), Mpumalanga (MP), North West Province (NWP), Lesotho (Les), endemic (E), introduced (I), dubious record (D) or widespread (W, species present outside of South Africa but not considered introduced). Genera endemic to South Africa are indicated by an asterisk (*). See Suppl. material 1: Table S1 for full collection and citation details.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
PODUROMORPHA						
Hypogastruridae						
Acherontiella thibaudi Barra, 1994	Barra 1994	KZN	W	Beach sand		South Africa and several tropical regions of East Africa and Southeast Asia (Thibaud 2010)
Austrogastrura lobata (Yosii, 1959)	Yosii 1959	WC	E		*Choreutinula lobata* Yosii, 1959	
Ceratophysella armata (Nicolet, 1842)	Womersley 1934, Paclt 1959, 1967, Coates 1970	WC, KZN, EC, FS, G, NC	D	Damp soil, moss, litter	*Hypogastrura armata* Nicolet, 1842	Western palaearctic distribution.
Ceratophysella armata trispina (Womersley, 1934)	Womersley 1934	WC	D		*Hypogastrura armata* var. *trispina* Womersley, 1934	Described from a single specimen with three anal spines, could also have been *Triacanthella* sp.
Ceratophysella longispina (Tullberg, 1876)	Womersley 1934	NC, KZN,	D		*Hypogastrura longispina* Tullberg, 1876	Northern hemisphere circumpolar distribution (Fjellberg 1998)
Hypogastrura manubrialis (Tullberg, 1876)	Womersley 1934, Paclt 1959, 1967	NC, KZN, WC	I	Wet habitat		Distributed worldwide, considered introduced in the Southern hemisphere
Hypogastrura manubrialis neglectus (Börner, 1901)	Womersley 1934	WC	D		*Hypogastrura manubrialis* var. *neglectus* (Börner, 1901)	Dubious: lacks two anal spines, no more information provided.
Hypogastrura purpurescens (Lubbock, 1868)	Womersley 1934, Paclt 1959, 1967	WC	I	Wet leaves	*Hypogastrura pseudopurpurascens* Womersley, 1928 in Womersley 1934 *Hypogastrura* (*Hypogastrura*) *purpurescens* (Lubbock, 1868) in Paclt 1959, 1967	The species can be considered as introduced from Northern hemisphere, as has recently been confirmed for Australia (Greenslade et al. 2014).
Hypogastrura sahlbergi (Reuter, 1895)	Paclt 1959	WC	D	Near stream		Dubious record: holarctic distribution (Bellinger et al. 1996–2014).
Hypogastrura sahlbergi rosea (Reuter, 1895)	Womersley 1934	WC	D	Damp rocks	*Hypogastrura sahlbergi* var. *rosea* (Reuter, 1895)	Agrees with *sahlbergi* s. str. except for colour. *Species inquirenda*.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Hypogastrura viatica (Tullberg, 1872)	Womersley 1934, Paclt 1959	WC	I	Littoral		Nordic countries and Arctic, considered introduced in southern hemisphere (Greenslade 2002).
Mesogastura libyca (Caroli, 1914)	Paclt 1959	WC	D	Forest litter	*Choreutinula libyca* Caroli, 1914	Probably *Austrogastrura lobata* (Yosii, 1959), present in the same locality.
Triacanthella madiba Janion, D'Haese & Deharveng, 2012	Janion et al. 2012	WC	E	Cave guano		
Willemia trilobata Barra, 1995	Barra 1995	KZN	E	Beach sand		
Xenylla capensis Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Xenylla maritima Tullberg, 1869	Paclt 1959, 1967	WC, EC, KZN, NWP	I	Wet habitat, forest		Cosmopolitan distribution (Fjellberg 1998), probably introduced in the Southern hemisphere
Xenylla rhodesiensis Womersley, 1929	Coates 1970	MP	E	Wet habitat		
Xenylla schillei Börner, 1903	Paclt 1959	Les	D	At stream		Only recorded from Europe, while the collection locality in South Africa is very isolated and at a high altitude
Xenylla yucatana Mills, 1938	Barra 1995	KZN	W	Forest soil		Pan-tropical distribution (Deharveng et al. 2011)
Brachystomellidae						
Brachystomella africana Yosii, 1959	Yosii 1959	WC	E		*Brachystomella parvula africana* Yosii, 1959	
Brachystomella coatesi Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Brachystomella georgensis Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Brachystomella parvula (Schäffer, 1896)	Womersley 1934, Paclt 1959, 1967, Coates 1970	MP, WC, KZN, EC, FS	I	Wet litter		Cosmopolitan distribution (Fjellberg 1998)
Probrachystomellides nicolaii Weiner & Najt, 1991*	Weiner and Najt 1991	WC	E	Forest leaf litter		
Setanodosa capitata (Womersley, 1934)	Womersley 1934	WC	E		*Brachystomella capitata* Womersley, 1934	
Neanuridae						

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Aethiopella capensis (Womersley, 1934)	Womersley 1934, Paclt 1959	WC, KZN	E	Stony stream	*Ceratrimeria flavoantennatus* var. *capensis* Womersley, 1934	
Aethiopella handschini (Denis, 1924)	Paclt 1959	Les, WC	D	Under stone, litter		Described and previously only known from Ethiopia (Massoud 1967)
Anurida maritima (Guérin-Méneville, 1836)	Womersley 1934, Paclt 1959, Yosii 1959, Lawrence 1953	WC, KZN	W	Littoral		Cosmopolitan distribution (Fjellberg 1998)
Ectonura barrai Janion, Bedos & Deharveng, 2011	Janion et al. 2011b	WC	E	Forest leaf litter		
Ectonura coatesi Barra, 1994	Barra 1994	KZN	E	Litter on dunes		
Ectonura monochaeta Janion, Bedos & Deharveng, 2011	Janion et al. 2011b	WC	E	Forest leaf litter		
Ectonura natalensis (Womersley, 934)	Womersley 1934, Paclt 1959	KZN, WC, EC	E	Litter	*Achorutes natalensis* Womersley, 1934 *Neanura natalensis* (Womersley, 1934)	
Ectonura oribiensis (Coates, 1968)	Coates 1968	KZN	E	Soil, litter	*Neanura oribiensis* Coates, 1968	
Friesea claviseta Axelson, 1900	Womersley 1934	KZN, WC	I	Litter		Cosmopolitan, possibly introduced in the southern hemisphere
Friesea versabilis Barra, 1995	Barra 1995	KZN	W	Under vegetation		Recorded from South Africa and Madagascar (Thibaud 2008)
Najtafrica riebi (Barra, 1994)*	Barra 1994	KZN	E	Dune litter	*Stachorutes riebi* Barra, 1994	
Neanura muscorum (Templeton, 1835)	Coates 1968a	EC	I	Litter		Sub-cosmopolitan, introduced in the southern hemisphere. All other species of the genus are in Europe.
Pseudachorutella africana Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Pseudachorutes alluaudi (Delamare Deboutteville, 1946)	Paclt 1959	KZN	W	Forest leaf litter	*Ceratrimeria alluaudi* Delamare Deboutteville, 1946	Described and only known so far from Eastern Africa (Massoud 1967).
Pseudachorutes univesicatus Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Vitronura joanna (Coates, 1968)	Coates 1968a	NWP	E	Soil	*Neanura joanna* Coates, 1968	
Odontellidae						

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Odontella sylvatica Weiner & Najt, 1991	Weiner and Najt 1991	WC	E	Forest leaf litter		
Odontellina deharvengi Barra, 1995	Barra 1995	KZN	W	Soil		Recorded from South Africa and Madagascar (Thibaud 2008)
Superodontella empodialis (Stach, 1934)	Paclt 1959	KZN	D		*Odontella empodialis* Stach, 1934	Dubious identification, European distribution
Onychiuridae						
Deuteraphorura inermis (Tullberg, 1869)	Womersley 1934, Paclt 1959	WC	D	Under stones	*Onychiurus fimetarius* (Linné, Lubbock) (sic) in Womersley 1934 *Onychiurus pseudinermis* Börner, Börner 1903 in Paclt 1959	Given the confusion around the species *fimetarius*, *inermis* and *pseudinermis*, and the age of the specimen slides, the identification given by authors (following Bellinger et al. 1996-2014) is uncertain.
Orthonychiurus camerunensis (Schött, 1926)	Paclt 1967	G	D	Soil	*Onychiurus camerunensis* Schött, 1926	The Schött description is insufficient to recognize the species.
Orthonychiurus saasveldensis (Weiner & Najt, 1991)	Weiner and Najt 1991	WC	E	Forest, on bark	*Onychiurus saasveldensis* Weiner & Najt, 1991	
Protaphorura armata (Tullberg, 1869)	Lawrence 1953	?	D		*Onychiurus armatus*	A holarctic distribution. Southern records of *Protaphorura* are usually *Thalassaphorura* species, or possible introductions.
Protaphorura matsumotoi (Kinoshita, 1923)	Paclt 1959	FS	D	Soil	*Onychiurus matsumotoi* Kinoshita, 1923	A *species inquirenda* after Yosii (1977), only recorded so far from Japan.
Tullbergiidae						
Delamarephorura capensis Janion, Weiner & Deharveng, 2013	Janion et al. 2013	WC	E	Soil		
Delamarephorura szeptyckii Barra & Weiner, 2009	Barra and Weiner 2009	EC	E	Dry grassland		
Fissuraphorura miscellanea Barra, 1995	Barra 1995	KZN	E	Soil		
Mesaphorura krausbaueri (Börner, 1901)	Womersley 1934, Paclt 1959	WC, EC, FS	D	Soil, under stones	*Tullbergia krausbaueri* Börner, 1901	Dubious identification, most *Mesaphorura* have been identified as *M. krausbaueri* before the split of this species by Rusek (1971). Older records are not reliable (Fjellberg 1998).

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Mesaphorura yosii (Rusek, 1967)	Barra 1995	KZN	W			Cosmopolitan distribution
Paratullbergia callipygos (Börner, 1902)	Womersley 1934	WC	I		*Tullbergia callipygos* Börner, 1902	Holarctic distribution
Tullbergia meridionalis Cassagnau & Rapoport, 1962	Barra 1995	KZN	W	Dune sand		Described from Argentina and later recorded from South Africa.
Tullbergia kilimanjarica (Delamare Deboutteville, 1953)	Paclt 1959, 1967, Coates 1970	WC, KZN, MP	W	Forest leaf litter, garden soil	*Mesaphorura kilimanjarica* Delamare Deboutteville, 1953	Described from Tanzania and later recorded from South Africa.
ENTOMOBRYOMORPHA						
Isotomidae						
Archisotoma sabulosa Barra, 1997	Barra 1997	KZN	E	Littoral dune sand		
Arlea tridens Barra, 1997	Barra 1997	KZN	E	Dune litter		
Ballistura schoetti (Dalla Torre, 1895)	Womersley 1934, Yosii 1959, Paclt 1959, 1967	WC, EC	I	Vegetation, rain pools	*Proisotoma schoetti* (Dalla Torre, 1895) in Womersley 1934 and Paclt 1959, 1967	Cosmopolitan distribution
Clavisotoma africana (Womersley, 1934)	Womersley 1934, Paclt 1959	WC	E	Wet leaves, rain pools	*Proisotoma africana* (Womersley, 1934)	
Folsomides americanus Denis, 1931	Paclt 1959, Barra 1997	KZN	W	From dry leaves		Cosmopolitan distribution
Folsomina onychiurina Denis, 1931	Barra 1997	KZN	W			Pantropical distribution
Hemisotoma thermophila (Axelson, 1900)	Womersley 1934, Paclt 1959, Coates 1970	KZN, WC	W	Under rotting leaves	*Isotoma bituberculata* Wahlgren, 1906 in Womersley 1934 and in Paclt 1959 *Isotomina thermophila* (Axelson, 1900) in Coates 1970	Cosmopolitan distribution. *Isotoma bituberculata* is proposed as a synonym of either *Hemisotoma thermophila* or *H. orientalis* (Stach, 1947) in Potapov (2001). We provisionally consider it as a synonym of *H. thermophila*, the most widespread species of the genus *Hemisotoma*.
Isotoma finitima Scherbakov, 1899	Paclt 1959	KZN	D		*Sorensia finitima* (Scherbakov, 1899)	The species is described without PAO, but body pigment is present; as such, it does not fit any known genus (Potapov 2001). Species inquirenda.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Isotoma mauretanica Handschin, 1926	Womersley 1934	WC	D			*Species inquirenda*. Stach (1947) considered this Algerian species as a possible member of the genus *Isotomurus*, but the description is too brief to support such a statement. See also *Isotomurus palustris.*
Isotomiella sodwana Barra, 1997	Barra 1997	KZN	E	Litter and humus on sand dunes		
Isotomodes productus (Axelson, 1906)	Womersley 1934	WC	I	Under stones		Subcosmopolitan, records from southern hemisphere scattered.
Isotomurus balteatus (Reuter, 1876)	Womersley 1934	WC	D		*Isotomurus palustris* var. *balteata* (Reuter, 1876).	*I. balteatus is* a species of Europe recognizable by its transversal stripes on tergites. We have seen such a colour pattern in South African Isotomidae of an undetermined genus which is not *Isotomurus*. The record of this species for South Africa is therefore dubious.
Isotomurus palustris (Müller, 1776)	Womersley 1934, Paclt 1959, 1967	WC, EC, G, KZN	I			Specimens of *Isotoma mauretanica* Handschin, 1926 recorded in Womersley 1934 were re-identified as *I. palustris* by Paclt (1959). This change is probably wrong, as Paclt states that specimens lack bothriotrichia.
Isotomurus tricuspis Börner, 1906	Paclt 1959, 1967	WC	D	Damp moss		Specimens of *Isotomurus palustris* var. *balteata* cited by Womersley (1934) are considered as *I. tricuspis* by Paclt (1959), based on similar pattern. of transversal stripes on tergites. However, these South African forms need to be examined morphologically to confirm their congeneric status with I. tricuspis from Java.
Micranurophorus musci Bernard, 1977	Barra 1997	KZN	W	Humid sand 20 cm under pioneer vegetation		Subcosmopolitan interstitial species.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Mucrosomia caeca (Wahlgren, 1906)	Paclt 1959	KZN, WC	W	From wet debris	*Cryptopygus caecus* Wahlgren, 1906	Current name after Potapov (2001).
Parisotoma mossopi (Womersley, 1934)	Paclt 1959	FS	E	From soil containing organic material	*Isotoma notabilis* ssp. *mossopi* Womersley, 1934	
Parisotoma notabilis (Schäffer, 1896)	Paclt 1959, 1967	WC	I	Wet leaves, leaf litter,	*Isotoma notabilis* Schäffer, 1896 in Paclt 1959, 1967	
Parisotoma obscurocellata Potapov, Janion & Deharveng, 2011	Potapov et al. 2011	WC	E	Litter under plants, coastal		
Parisotoma sexsetosa Potapov, Janion & Deharveng, 2011	Potapov et al. 2011	WC	E	Forest leaf litter		
Pauropygus caussaneli (Thibaud, 1996)	Barra 1997	KZN	W	Littoral sand	*Cryptopygus riebi* Barra, 1997	Synonymy after Potapov, Gao and Deharveng 2013. On the coasts of Indian and Atlantic Oceans
Proisotoma davidi Barra, 2001	Barra 2001	EC	E	Grassland soil		
Proisotoma minuta (Tullberg, 1871)	Paclt 1959, 1967	WC, KZN, FS, EC	I	Litter		Cosmopolitan species.
Entomobryidae						
Capbrya marshalli Barra, 1999*	Barra 1999	EC	E	Grassland		
Capbrya themeda Barra, 1999*	Barra 1999	EC	E	Grassland		
Coecobrya caeca (Schött, 1896)	Goto 1953	WC	D	In cave	*Sinella coeca* (Schött, 1896)	*C. coeca* is restricted to northern America according to Chen and Christiansen (1997), and unlikely to have been introduced in South African caves. The South African species might be the cosmopolitan *C. tenebricosa* (Folsom, 1902) (Zhang et al. 2009)
Coecobrya hoefti (Schäffer, 1896)	Paclt 1959	WC	D	In cave		Extra-European records are dubious (Jordana 2012). The Paclt specimens, from the same locality as the Goto (1953) specimens, may rather belong to the cosmopolitan species *C. tenebricosa* (Zhang et al. 2009)

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Entomobrya atrocincta Schött, 1897	Paclt 1967	WC	I?	Litter		The large distribution of the species makes it difficult to determine from which region it may have been introduced. In addition, most colour patterns described in the literature do not fit the original and clear description of Schött (1897).
Entomobrya decemfasciata (Packard, 1873)	Womersley 1934	WC	D			Contrary to the claim of Womersley, *E. decemfasciata* does not occur in "most temperate parts of the world, including Europe". Reliable records are restricted to North America. The colour pattern given by Womersley is different from that given by Christiansen and Bellinger (1998) for specimens of the USA.
Entomobrya lanuginosa (Nicolet, 1842)	Womersley 1934	WC	I?		*Entomobrya nivalis* Linnaeus, 1758 f. *immaculata* Schäffer, 1896	The cited form is tentatively reported to *E. lanuginosa*. In that case it would be an introduced species.
Entomobrya minima Brown, 1926	Brown 1926	KZN	E	Under stone		
Entomobrya multifasciata (Tullberg, 1871)	Paclt 1967	WC, NC, G	I	Litter, next to stream		Widespread in the holarctic region.
Entomobrya nicoleti (Lubbock, 1876)	Womersley 1934	WC	I?		*Entomobrya nivalis* f. *maculata* Schäffer, 1896	The cited form is tentatively reported to *E. nicoleti*. In that case it would be an introduced species.
Entomobrya nivalis (Linnaeus, 1758)	Paclt 1959, 1967, Coates 1970	WC, EC, FS, KZN	I	Litter, rainwater pool		Cosmopolitan distribution, but most reliable records are in the holarctic region.
Lepidocyrtus cyaneus Tullberg, 1871	Paclt 1959	KZN, EC	I?	Dry leaves, damp soil		Cosmopolitan distribution, but considered introduced in southern hemisphere where other related species are absent.
Lepidocyrtus ferrugineus (Schött, 1893)	Paclt 1959	KZN	D	Dry leaves		Described from Africa, the species needs a modern redescription to be recognizable.
Lepidocyrtus lanuginosus (Gmelin, 1788)	Womersley 1934, Paclt 1967	WC	D	Litter		Records of this species from the southern hemisphere need to be checked.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Lepidokrugeria meyerae Coates, 1969*	Coates 1969	MP	E	Dead leaves		
Orchesella hexfasciata (Harvey, 1896)	Paclt 1959	FS, G	D	Litter	*Entomobrya hexfasciata* Harvey, 1896	Assigned to the genus *Entomobrya* by Paclt (1959), today considered as an *Orchesella* (Christiansen and Bellinger 1998). All reliable records are from the USA.
Pseudosinella alba (Packard, 1873)	Paclt 1959	WC, EC	I	Litter		Cosmopolitan distribution, but most reliable records are in the holarctic region.
Pseudosinella biguttata Barra 1997	Barra 1997	KZN	E	Sand forest litter		
Pseudosinella immaculata (Lie–Pettersen, 1897)	Paclt 1959	KZN	D			All reliable records of this species are from Western Europe (Gisin and Da Gama 1972), following major taxonomic changes in species delimitations introduced in the 60'
Pseudosinella octopunctata Börner, 1901	Paclt 1959	WC, FS	I?	Wet litter		Subcosmopolitan distribution, but most tropical and southern hemisphere records need confirmation.
Seira addoensis Coates, 1968	Coates 1968	EC	E	Soil and vegetation		
Seira anncla Coates, 1968	Coates 1968, 1970	EC, WC	E	Shore vegetation		
Seira annulicornis (Börner, 1903)	Yosii 1959, Coates 1968, 1970	WC, MP, G, FS, KZN,	W		*Seira* (*Lepidocyrtinus*) *annulicornis* (Börner , 1903) in Yosii 1959	African distribution
Seira annulipes (Handschin, 1929)	Womersley 1934	KZN, WC	W	On vegetation	*Lepidocyrtus annulipes*, mispelling for *Lepidocyrtinus annulipes* Handschin, 1929	African distribution. Redescription needed on modern *standards*.
Seira annulosa (Wahlgren, 1906)	Womersley 1934	WC	D	Shore vegetation	*Lepidocyrtinus flavovirens* var. *annulosa* Wahlgren, 1906	Species previously known from Sudan; morphological features given by Wahlgren and Womersley do not allow reliable identification.
Seira barnardi (Womersley, 1934)	Womersley 1934, Yosii 1959, Paclt 1959, 1967, Coates 1968, 1970	WC, NWP	E	Wet leaves	*Lepidocyrtinus cooperi* var. *barnardi* Womersley, 1934 *Seira* (*Lepidocyrtinus*) *barnardi* (Womersley, 1933) (sic)	

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Seira capensis (Womersley, 1934)	Womersley 1934, Yosii 1959, Coates 1968	WC, EC	E	On vegetation	*Lepidocyrtinus capensis* Womersley, 1934 *Seira* (*Seira*) *capensis* (Womersley, 1934) in Yosii 1959	
Seira damerella Coates, 1968	Coates 1968, 1970	L, MP	E	Litter		
Seira dayi Yosii, 1959	Yosii 1959, Coates 1968	WC	E		*Seira* (*Lepidocyrtinus*) *dayi* Yosii, 1959	
Seira eleana Coates, 1968	Coates 1968, 1970	MP	W	From dry vegetation		Also recorded from Mozambique by Coates (1968) and from Yemen by Barra (2004)
Seira flavovirens (Börner, 1903)	Womersley 1934, Yosii 1959, Coates 1968	WC	D		*Lepidocyrtinus flavovirens* Börner, 1903 in Womersley 1934; author should be (Börner, 1903) *Seira* (*Seira*) *flavovirens* (Börner, 1903) in Yosii 1959	May correspond to several whitish species of *Seira*.
Seira grisea (Womersley, 1934)	Womersley 1934, Coates 1968	WC	E	From vegetation	*Pseudosira grisea* Womersley, 1934	Possibly a synonym of *Seira flavovirens* according to Yosii (1959)
Seira grisea annulata (Womersley, 1934)	Womersley 1934	WC	D		*Pseudosira grisea* var. *annulata* Womersley, 1934	The taxonomic value of this form is uncertain. This variety might be synonym of *S. flavovirens* after Yosii (1959).
Seira incerta (Handschin, 1926)	Womersley 1934	WC	D	Estuary	*Lepidocyrtinus incertus* Handschin, 1926	The species has a characteristic colouration, but is only known from the Mediterranean region where it is uncommon, so unlikely to have been introduced to South Africa.
Seira laeta (Börner, 1908)	Börner 1908	NC	E		*Pseudosira* (*Mesira*) *laeta* Börner, 1908	
Seira lindei Coates, 1968	Coates 1968	EC, WC	E	Wet litter		
Seira marephila Coates, 1968	Coates 1968	EC, WC	E	Litter		
Seira mathewsi Coates, 1968	Coates 1968, 1970	EC, WC	E	From vegetation		
Seira metala Coates, 1968	Coates 1968	WC	E	Litter		
Seira metarsiosa Coates, 1968	Coates 1968	FS, NC	E	From grass		
Seira munroi (Paclt, 1959)	Paclt 1959	NC	E	In ants' nest	*Diamantinum munroi* Paclt, 1959	Transferred to *Seira* by Salmon (1964)
Seira nagatai Yosii, 1959	Yosii 1959	WC	E		*Seira* (*Seira*) *nagatai* Yosii, 1959	
Seira pallens (Börner, 1908)	Börner 1908	NC	E		*Pseudosira nyassica* var. *pallens* Börner, 1908	

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Seira pseudocoerulea (Denis, 1924)	Womersley 1934, Yosii 1959	WC	D	Estuary	*Lepidocyrtinus pseudocoeruleus* (Denis, 1924) in Womersley 1934	African species. A study of the chaetotaxy of Ethiopian specimens would be however necessary to confirm identification (Yosii 1959).
Seira rowani Yosii, 1959	Yosii 1959, Coates 1968, 1970	WC	E	On vegetation	*Seira* (*Afroseira*) *rowani* Yosii, 1959	
Seira rykei Coates, 1968	Coates 1968	WC	E	On vegetation		
Seira squamoornata (Scherbakov, 1898)	Paclt 1959, 1967	KZN, WC, FS, G, NC	D	Soil and vegetation		The numerous records of this species by Paclt are all dubious, and concern various endemic species of the genus. *S. squamoornata* is today considered to be limited to the Palaearctic region.
Seira tsikama Coates, 1968	Coates 1968, 1970	WC	E	Forest leaf litter		
Seira vaneedeni Coates, 1968	Coates 1968	KZN	E	From shrub and grass		
Cyphoderidae						
Calobatinus rhadinopus (Börner, 1913)	Börner 1913, Paclt 1967	KZN, G	E	Termite nest	*Calobatella rhadinopus* Börner, 1913	
Cyphoda colura (Börner, 1908)	Börner 1908	NC	E	Termite nest	*Cyphoderus colurus* Börner, 1908	
Cyphoda limboxiphia (Börner, 1913)	Börner 1913, Paclt 1967	KZN, G	E?	Termite nest	*Cyphoderus limboxiphius* Börner, 1913	
Cyphoda natalensis (Börner, 1913)	Börner 1913, Womersley 1934	KZN, WC	E	Termite nest	*Cyphoderus natalensis* Börner, 1913	
Cyphoderus assimilis (Börner, 1906)	Paclt 1959	KZN	W	Ant nest		Cosmopolitan distribution
Cyphoderus bidenticulatus Parona, 1888	Börner 1913	KZN	E	Termite nest		
Cyphoderus omoensis Delamare Deboutteville, 1945	Paclt 1959, Womersley 1934	WC	D	In cave	*Cyphoderus arcuatus* var. *aethiopicus* Hanschin, 1929 in Womersley 1934,	Wrong identification of Womersley after Paclt (1959)
Cyphoderus squamidives Silvestri, 1918	Silvestri 1918, Paclt 1959, 1967	KZN, WC, G	E?	Termite nest	*Cyphoderus arcuatus* var. *squamidives* in Silvestri 1918	
Cyphoderus trinervoidis Paclt, 1965	Paclt 1965	G	E	Termite nest		
Pseudocyphoderus wasmanni Börner, 1913	Börner 1913, Paclt 1967	KZN, G	E	Termite nest		

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Paronellidae						
Dicranocentruga nigromaculata (Schött, 1903)	Paclt 1959	KZN	W		*Paronella nigromaculata* Schött, 1903 in Paclt 1959	African species. The generic name *Dicranocentruga* Wray, 1953 was reactivated by Mitra (2002)
Tomoceridae						
Neophorella dubia Womersley, 1934*	Womersley 1934	WC	E			
NEELIPLEONA						
Neelidae						
Megalothorax minimus (Willem, 1900)	Paclt 1967	WC	W	Damp soil, moss		Cosmopolitan species, currently in course of splitting. South Africa specimens will have to be re-examined.
SYMPHYPLEONA						
Sminthurididae						
Denisiella serroseta (Börner, 1908)	Börner 1908, Paclt 1959	NC	W		*Sminthurides* (*Stenacidia*) *serroseta* in Börner 1908; *Sminthurides* (*Denisiella*) *serroseta* in Paclt 1959	African species
Sphaeridia minima (Schött, 1893)	Paclt 1959, 1967	FS, WC	D	From soil	*Sminthurides* (*Sphaeridia*) *minimus* (Schött, 1893)	*S. minima* is distributed in western Africa. It is very similar, if not identical, to the cosmopolitan species *S. pumilis* Krausbauer, 1898. Bretfeld (1999) considers that the Paclt specimens may belong to *S. pumilis*, but that those from Cameroon may represent distinct species. A revision of these tropical *Sphaeridia* is clearly needed.
Katiannidae						
Katianna kerguelenensis Denis, 1947	Paclt 1959	KZN	D			The South African records of this sub-Antarctic species need confirmation.
Sminthurinus mime (Börner, 1907)	Womersley 1931, Paclt 1959, Paclt 1967	WC	W	Beneath vegetation	*Sminthurinus terrestris* Womersley, 1931	Paclt (1959) mentions differences between the two species, that are nevertheless synonymized by Greenslade (1994). Widely distributed in the southern hemisphere and in tropical Asia.

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Sminthurinus niger (Lubbock, 1873)	Womersley 1931, Paclt 1959	WC	I	Under loose bark		Mostly holarctic. Tropical and Australian records may be the result of introductions.
Sminthurinus pallidus Womersley, 1931	Womersley 1931, Paclt 1959	WC	E	Beneath vegetation	*Sminthurinus terrestris* Womersley, 1931 in Paclt 1959	The synonymy of *S. pallidus* Womersley 1931 with *S. terrestris* proposed by Paclt (1959) is based on unsufficient ground and not accepted here.
Stenognathellus stenognathus (Börner, 1907)	Paclt 1959	WC, KZN	W	Litter	*Sminthurinus stenognathus* (Börner, 1907)	Africa and Argentina.
Dicyrtomidae						
Dicyrtomina africana Womersley, 1931	Womersley 1931	WC	E	On vegetation	*Dicyrtomina minuta* form *africana* Womersley, 1931	The validity of this form needs confirmation.
Dicyrtomina minuta (O. Fabricius, 1783)	Paclt 1959, 1967	WC	I	At stream, on vegetation		Northern hemisphere, probably introduced in southern regions. Paclt considered *Dicyrtoma minuta* f. *africana* as identical with *D. minuta*.
Bourletiellidae						
Bourletiella arvalis (Fitch, 1863)	Paclt 1959	WC	I	Lucerne pasture	*Bourletiella* (*Bourletiella*) *arvalis* (Fitch, 1863)	Northern hemisphere, with local occurrence in southern hemisphere where it has been probably introduced.
Prorastriopes barnardi (Womersley, 1931)	Womersley 1931, Paclt 1959	WC	E	Amongst grass	*Deuterosminthurus marmoratus* var. *barnardi* Womersley, 1931	A colour form of *P. marmoratus*. Paclt (1959) synonymized this form with *R. schultzei* on insufficient evidence.
Prorastriopes marmoratus (Womersley, 1931)	Womersley 1931, Paclt 1959	WC	E	Rainwater pools	*Deuterosminthurus marmoratus* Womersley, 1931	Paclt (1959) synonymized this species with *R. schultzei* on insufficient evidence.
Prorastriopes schultzei (Börner, 1908)	Börner 1908	WC, G, NC	E	Among vegetation, wet habitat	*Bourletiella schultzei* in Börner, 1908	Generic assignation after Betsch (1980). Paclt (1959) proposes to synonymize *P. marmoratus*, *P. banardi* and *P. schultzei*, with *R. lineata* on weak morphological evidence as all these species are too briefly described. The same author considers in 1967 that his previous citation of *schultzei* (in Paclt 1959) as *Rastriopes lineatus* (here *R. lineata*).

Current species name	Source	Province recorded from in SA	Status	Habitat if given in source	Name published in source if different from the current one	Comments
Prorastriopes webbi Paclt, 1964	Paclt 1964, Coates 1970	KZN, MP, EC	E	On vegetation, litter		
Rastriopes lineata Womersley, 1931	Womersley 1931, Paclt 1959, 1967	WC, NC, G	E	Under a fallen twig and on rainwater pool (Womersley 1931), on vegetation (Paclt 1959), moss and rotten leaves, grass on river banks (Paclt 1967)	*Rastriopes schultzei* in Paclt 1959	Paclt (1959) synonymized this species with *R. schultzei*, but in 1967 considered that the specimen he identified as *schultzei* in Paclt (1959) was in fact *R. lineata*, bona species.
Tritosminthurus schuhi Snider, 1988*	Snider 1988	WC	E			
Sminthuridae						
Papirinus prodigiosum Yosii, 1954	Paclt 1959	KZN	D		*Sphyrotheca prodigiosa* (Yosii, 1954)	The genus *Papirinus*, placed among Katiannidae in Bretfeld (1999), is considered here as closer to Sminthuridae. This species is only known from Japan. Other species exist in Madagascar, Sumatra, Thailand and Congo. The South African species is probably new (Betsch 1980).
Sminthurus viridis (Linnaeus, 1758)	Lawrence 1953, Paclt 1959	WC	I	On vegetation		Mainly holarctic species, thought to have been introduced from Europe (via Australia) as eggs in soil through the importation of clover seed (Wallace 1968, Wallace and Walters 1974).

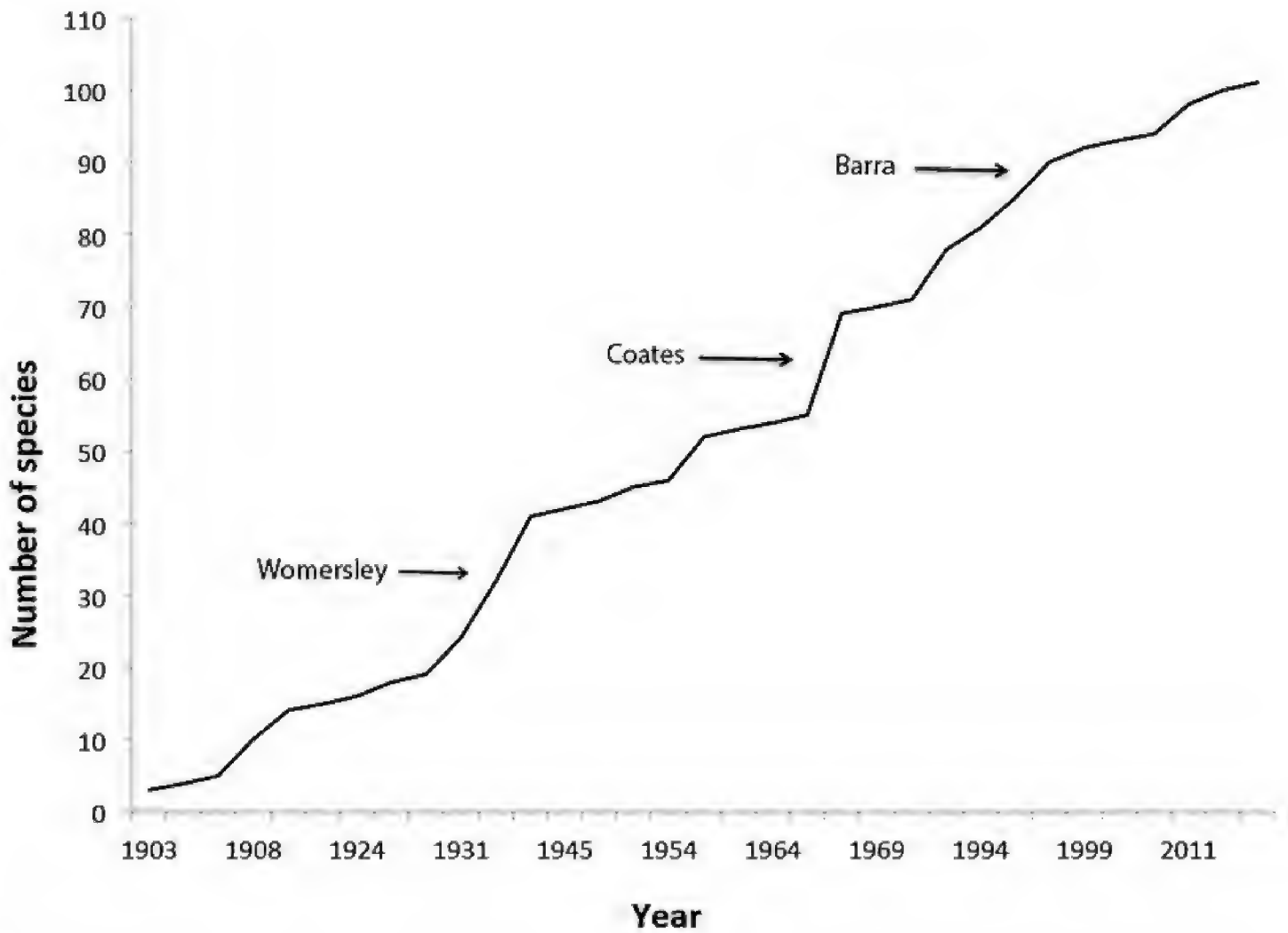

Figure 1. The cumulative number of Collembola species described from South Africa. The three major increases in described species are indicated by the author names (Womersley, Coates and Barra).

Discussion

The number of Collembola species recorded for South Africa is low compared to well-studied regions such as Europe (Deharveng 2007), but is the highest of all African countries south of Sahara (Thibaud 2013). Low sampling intensity in Africa seems to be the main reason for this pattern. Based on new records and species discovered during recent systematic sampling in the Western Cape Province alone (Janion et al. 2011a, b, Potapov et al. 2011, Janion et al. 2012, Liu et al. 2012, Janion et al. 2013), it is clear that many species remain to be recorded and described for this province. Given low richness documented elsewhere in South Africa the same situation is likely to be the case both there and in other African countries. The spatial distribution of species richness records also suggests that incomplete sampling coverage lies at the heart of the current diversity patterns. Most records to date have come from those provinces where taxonomists were either based or hosted such as in Cape Town of the Western Cape Province (Womersley 1934, Paclt 1959, Yosii 1959), and in Pretoria of the Gauteng Province (Coates 1969), reflecting a recurrent bias in geographic patterns of diversity of poorly known groups (Deharveng et al. 2000). Although Collembola do generally prefer moist environments (Hopkin 1997), which may mean lower diversity in arid provinces such as the Northern Cape and North-West Provinces (see Mucina and Rutherford 2006),

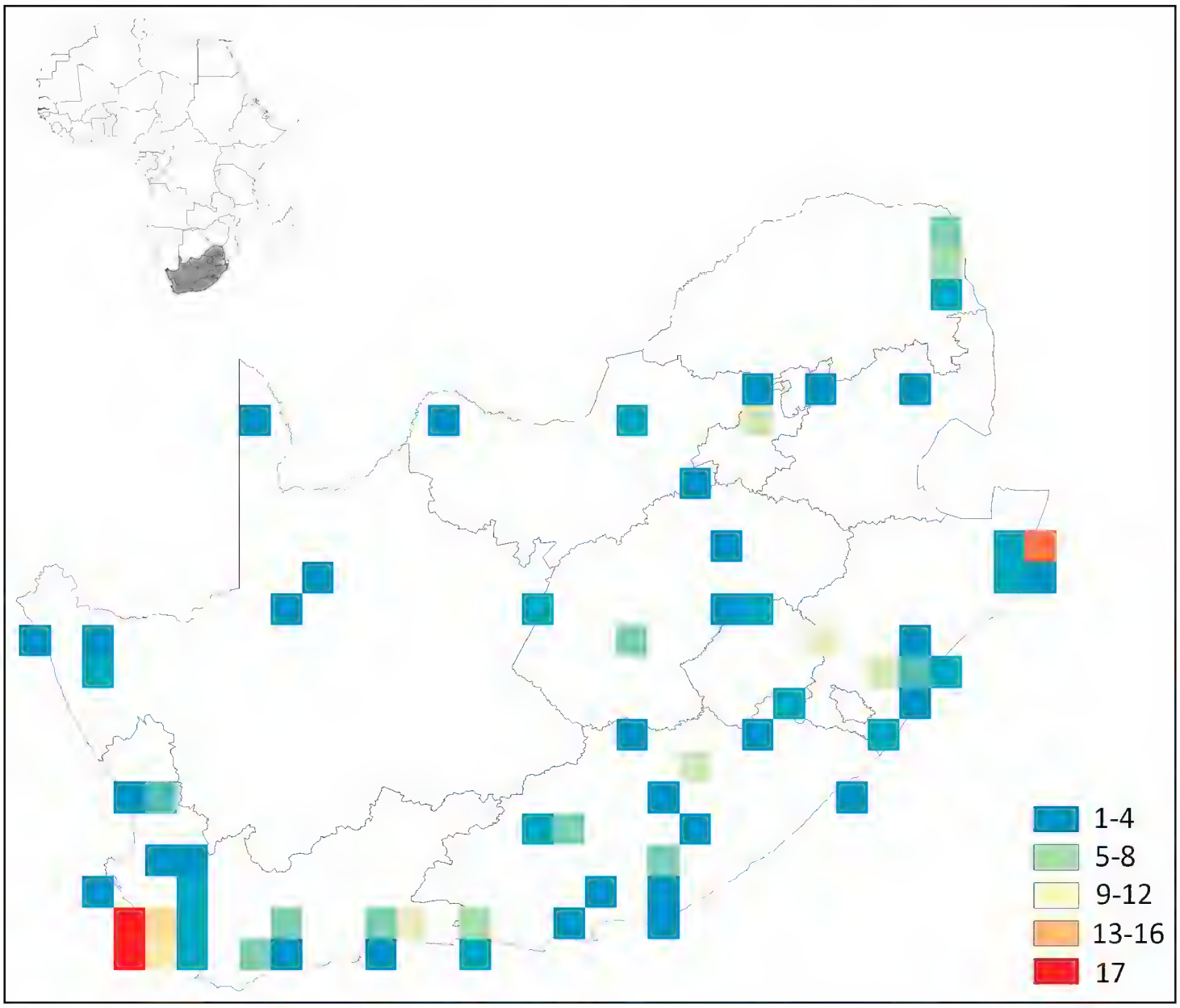

Figure 2. Number of Collembola species recorded for each degree square grid in South Africa.

low species richness in provinces such as Limpopo and Kwazulu-Natal is at odds with most other groups in the country (see e.g. Davis 1997 for dung beetles, Erasmus et al. 2000 for antlions, Foord et al. 2002 for spiders, Evans et al. 2006 for amphibians and birds, Schoeman and Foord 2012 for ants). The only exception to the poor knowledge of the fauna is for the sub-Antarctic Prince Edward Island group (consisting of Marion Island and the smaller Prince Edward Island), which is geopolitically a part of South Africa, and for which the fauna has been thoroughly investigated (Table 3, Gabriel et al. 2001, Hugo et al. 2006, Chown and Froneman 2008). Such a general situation of poor knowledge is typical for the Collembola in many parts of the world (e.g. Cicconardi et al. 2013), and will hamper efforts both to conserve this diversity (Cardoso et al. 2011) and to understand which components of it are non-indigenous and may be having impacts on the indigenous fauna (see discussion in Roques et al. 2009).

With the caveat in mind of undersampling, both in many parts of Africa and country-wide, it is worth considering what the current information on species in the country suggests. It appears that endemicity is likely to be high (currently 65%). This value is similar to that found for other invertebrate groups and plants in South Africa, with

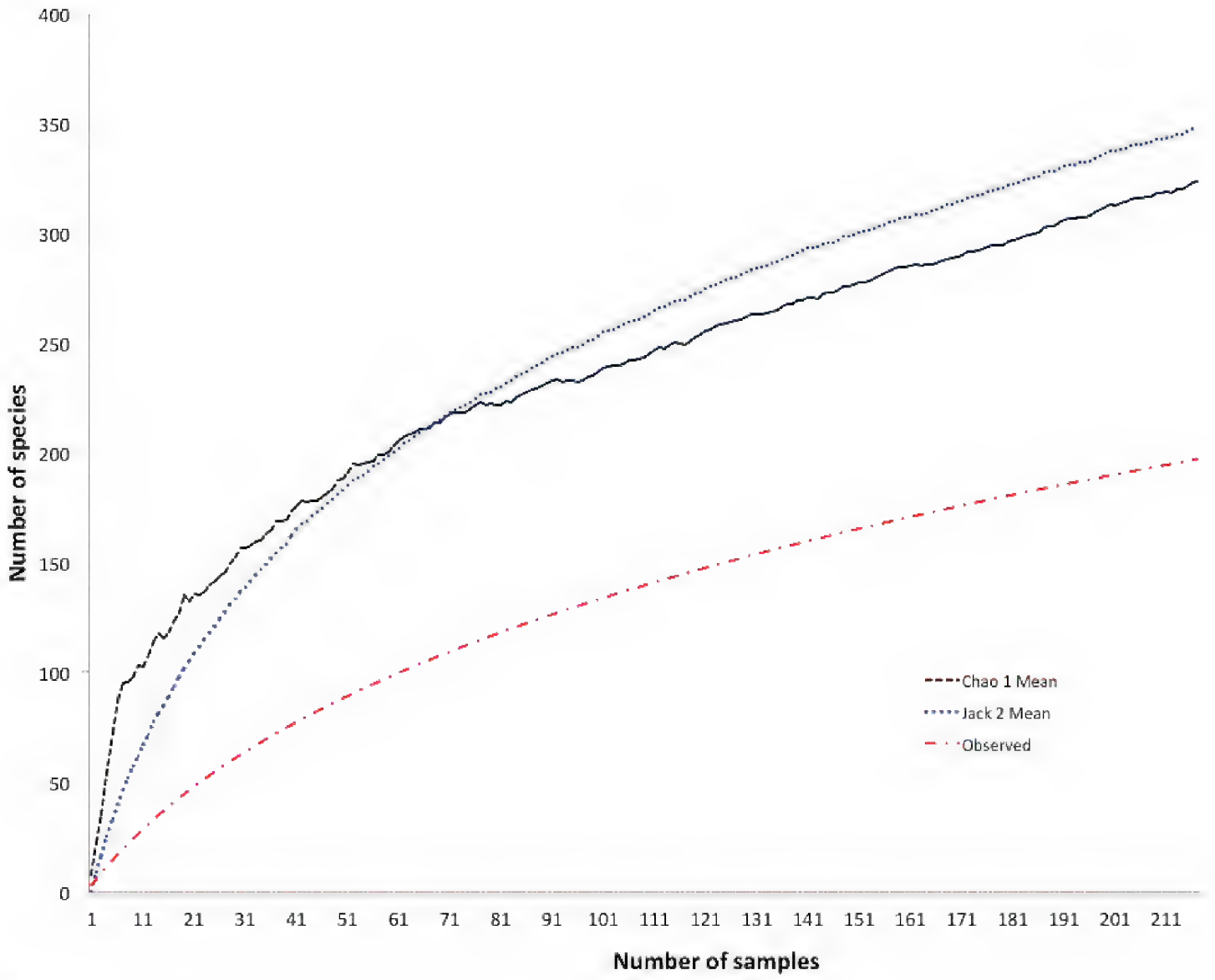

Figure 3. A sample-based rarefaction curve for the Western Cape, for observed species richness, and the Chao1 and Jacknife2 Estimators.

an extraordinary high number of endemic species found in the south-western Cape (see Colville et al. 2002, Goldblatt and Manning 2002, Herbert and Kilburn 2004, Rebelo et al. 2006, Pryke and Samways 2010). Endemicity is expected to increase with local sampling, but will likely decline if sampling is undertaken in neighbouring countries where information on the group is similarly low (e.g. Namibia, see Thibaud and Massoud 1988). Currently, sampling in the southern part of Africa mostly concerns sites within South Africa, generating a rapid increase in species richness and endemicity, as many additional endemic species have been obtained from samples as little as a few kilometres from already well sampled areas (Janion-Scheepers, Bedos and Deharveng unpublished results).

Currently, six genera are thought to be endemic to South Africa: *Najtafrica* Barra, 2002 (one species, Pseudachorutinae), *Probrachystomellides* Weiner & Najt, 1991 (one species, Brachystomellidae), *Capbrya* Barra, 1999 (two species, Entomobryidae), *Lepidokrugeria* Coates, 1969 (one species, Lepidocyrtinae), *Neophorella* Womersley, 1934 (one species, Tomoceridae) and *Tritosminthurus* Snider, 1988 (one species, Bourletiellidae). *Neophorella dubia* was described from a single specimen by Womersley (1934) and is the only endemic species of the family Tomoceridae to occur in South Africa.

Table 3. Species recorded from the Prince Edward Islands, an island group geopolitically part of South Africa. Abbreviations used: E = endemic to Marion Island, S = sub-Antarctic distribution, I = introduced, D = dubious.

Current species name	Source	Status	Name in source and comments
PODUROMORPHA			
Hypogastruridae			
Ceratophysella denticulata (Bagnall, 1941)	Deharveng (1981)	I	*Ceratophysella* cf. *denticulata* (Bagnall, 1941)
Hypogastrura viatica (Tullberg, 1872)	Deharveng (1981)	D	Not found again since 1981, possible contamination (CJS pers. obs.)
Neanuridae			
Friesea tilbrooki Wise, 1970	Deharveng (1981)	S	*Friesea viennei* Deharveng, 1981 (syn Greenslade 1986)
Tullbergiidae			
Tullbergia bisetosa Börner, 1902	Deharveng (1981)	S	
ENTOMOBRYOMORPHA			
Isotomidae			
Cryptopygus antarcticus travei Deharveng, 1981	Deharveng (1981)	E	
Cryptopygus dubius Deharveng, 1981	Deharveng (1981)	S	
Cryptopygus tricuspis Enderlein, 1909	Deharveng (1981)	S	
Folsomotoma marionensis (Deharveng, 1981)	Deharveng (1981)	E	*Isotoma* (*Sorensia*) *marionensis* Deharveng, 1981
Isotomurus maculatus Müller, 1876	Deharveng (1981)	I	*Isotomurus* cf. *palustris*, confirmed as *I. maculatus* by Greenslade (2010)
Mucrosomia caeca (Wahlgren, 1906)	Deharveng (1981)	S	*Cryptopygus caecus* Wahlgren, 1906 (new comb. after Potapov 2001)
Parisotoma notabilis (Schäffer, 1896)	Deharveng (1981)	I	*Isotoma* (*Parisotoma*) *notabilis*
Tomoceridae			
Pogonognathellus flavescens (Tullberg, 1871)	Gabriel et al. (2001)	I	
NEELIPLEONA			
Neelidae			
Megalothorax minimus Willem, 1900	Deharveng (1981)	I	*Megalothorax* cf. *minimus* Willem, 1900, identification confirmed by C. Schneider (pers. comm.)
SYMPHYPLEONA			
Katiannidae			
Sminthurinus granulosus Enderlein, 1909	Deharveng (1981)	S	*Sminthurinus* cf. *granulosus* Enderlein, 1909 in Deharveng (1981)
Sminthurinus tuberculatus Delamare Deboutteville & Massoud, 1963	Gabriel et al. (2001)	S	*Sminthurinus* cf. *kerguelensis* Salmon, 1964 in Deharveng (1981)
Katianna sp.	Chown and Froneman (2008)	E	

Paclt (1959) mentioned that besides the single holotype specimen, this species was not found again and he synonymised it with the Paronellidae *Dicranocentruga nigromaculata* (Schött, 1903). Ireson and Greenslade (1990) re-examined the type specimen and re-assigned the species to Tomoceridae, stressing however its similarity with Isotomidae

(Skaife 1954). In spite of intensive sampling in its type locality of Table Mountain (Janion-Scheepers, Bedos and Deharveng unpublished results), the species was not retrieved in any of our samples, and is considered here as a *species inquirenda*.

The current information also suggests that approximately 20% of the Collembola species found in South Africa may have been introduced by humans to the region and should therefore be considered alien (see Pyšek et al. 2004 for terminology). Understanding what the proportion of introduced species in the fauna actually is will depend on additional comprehensive sampling, and on further consideration of species currently though to be alien. Thus, several species resembling well-known European taxa had previously been mistakenly assigned to these taxa. For example, *Seira squamoornata*, which was originally described from the Ukraine, was thought to be a common polymorphic species in South Africa after Paclt (1959). However, Yosii (1959) did not even include this species in his list, while Coates (1968b) found that specimens labelled as one species (*S. squamoornata*) by Paclt (1959), could actually be identified as several endemic species described by Yosii (1959) or Coates (1968b), and concluded that this European species does not occur in South Africa. Indeed, to date 25 indigenous species of *Seira* have been described from South Africa (Yosii 1959, Coates 1968b), and the richness of the genus is likely much larger.

Nonetheless, that several alien species are present, especially of European origin, is not surprising given the close historical links between South Africa and Europe (Giliomee and Mbenga 2007). Most of the invasive species were collected in disturbed environments, in gardens or close to human settlements (Supplementary Material Suppl. material 1) bearing out findings for a range of other groups that disturbance may favour alien species establishment (Chytrý et al. 2005, MacDougall and Turkington 2005, Richardson and Pyšek 2006). Perhaps the best known of the alien species is *Sminthurus viridis*, also known as the Lucerne flea (Wallace 1964, Wallace and Walters 1974), which received considerable attention in South Africa during the late 1960s due to its pest status. It is thought to have arrived from Australia as eggs in soil through the importation of clover seed (Walters 1968, Wallace and Walters 1974). It was first collected in 1951 near Somerset West and by 1959 over 50 000 hectares of Lucerne were infested (Wallace and Walters 1974). The problem now appears largely to have been resolved, although the species is still listed as a pest of Lucerne (Annecke and Moran 1982).

In conclusion, based on published knowledge only, the Collembola species richness of South Africa is high compared with other African countries (Thibaud 2013), but low compared with non-African countries (Deharveng 2007) and with the richness of other invertebrate groups in the South African region (Scholtz and Chown 1995). This is likely due to undersampling, as recent discoveries (e.g. Janion et al. 2011b, Potapov et al. 2011, Janion et al. 2012, 2013) have indicated. Owing to a recent, large and comprehensive ecological and systematic study, accompanied by DNA Barcoding (Porco et al. 2012) largely focused on the country's Western Cape Province (Bengtsson et al. 2010, Janion et al. 2011a, Liu et al. 2012), a substantial increase in the number of species is expected. With 67 species recognised for the Western Cape from the recorded literature, the richness estimates indicating at least 6–7 times that

number being present, and based on experience in other undersampled countries such as Thailand (Bedos 1994), we expect that species richness for the country will exceed 1000. Improvement of systematic knowledge through studies such as these, and improvements in ecological understanding of the impacts of both landscape change and invasive species on the springtail fauna (e.g. Gabriel et al. 2001, Liu et al. 2012), will help South Africa meet its commitments to biodiversity conservation especially as set out in the 2020 Aichi Biodiversity Targets.

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Supplementary material 1

Table S1

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Data type: occurrence

Explanation note: Collection details of Collembola recorded from continental South Africa.

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